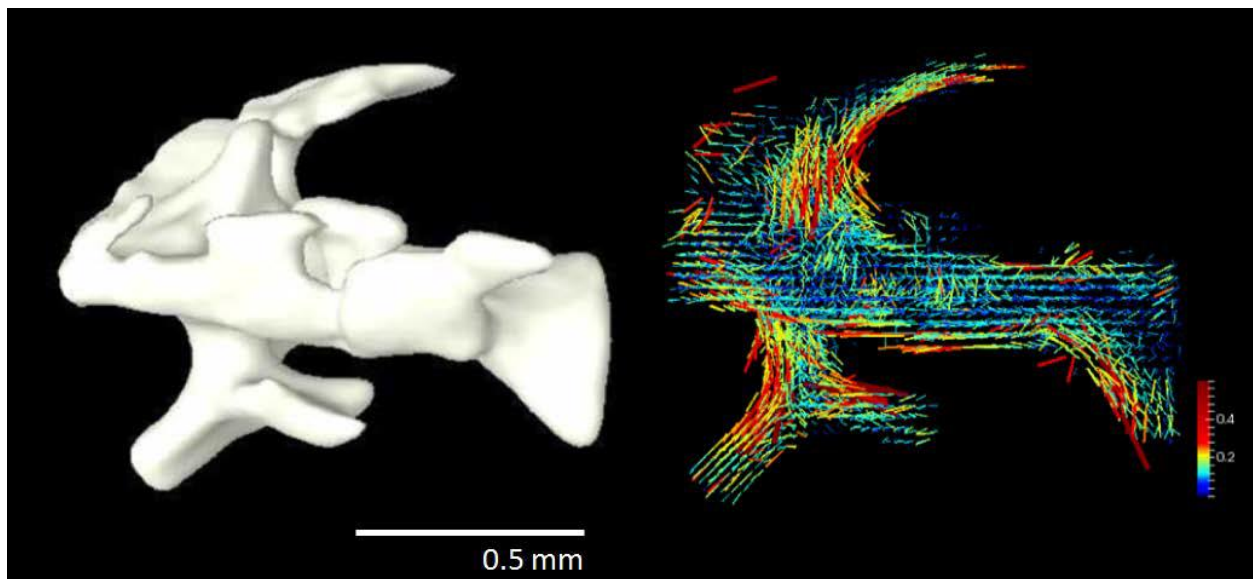


## Small-angle Scattering Tensor Tomography: Bridging the Gap between Nano- and Mesoscale

Marianne Liebi<sup>a</sup>, Marios Georgiadis<sup>b</sup>, Andreas Menzela, Philipp Schneider<sup>c</sup>, Joachim Kohlbrechera, Oliver Bunka and Manuel Guizar-Sicairosa

<sup>a</sup>Swiss Light Source, Paul Scherrer Institut, Villigen, Switzerland blnsitute for Biomechanics, ETH Zurich, Zurich, Switzerland <sup>c</sup>Bioengineering Science Research Group, University of Southampton, Southampton, UK <sup>d</sup>Swiss Spallation Neutron Source, Paul Scherrer Institut, Villigen, Switzerland

Small-angle X-ray scattering in scanning mode allows probing nanoscale features in a spatially resolved fashion. For heterogeneous samples, in which the structure changes over macroscopic length scales, this method offers a valuable tool to bridge the nanoscale of structural elements to specimen with dimensions of several millimetres or even centimetres. We combine small-angle X-ray scattering with computed tomography for the measurement of three-dimensional samples. Our algorithm reconstructs the full 3D reciprocal space map in each voxel using spherical harmonics as a model and allows retrieving the 3D orientation and degree of orientation of the investigated nanostructure. We have demonstrated the technique on a piece of human trabecular bone, analyzing the orientation of its mineralized collagen fibrils.[1]



**Figure 1.** CT reconstruction of human trabecular bone, retrieved from the transmitted X-ray intensity using standard filtered backprojection (left) and orientation of the bone ultrastructure as retrieved from Small-angle X-ray tensor tomography (right).

[1] Liebi, M., Georgiadis, M., Menzel, A., Schneider, P., Kohlbrecher, J., Bunk, O., Guizar-Sicairos, M. Nanostructure surveys of macroscopic specimens by small-angle scattering tensor tomography. *Nature* **2015**, 527, 349-352.